Damage Caused by *Spodoptera frugiperda* J.E Smith on Corn in Climate Zones in South Sulawesi, Indonesia

**Abstract.** Corn as one of the main commodities in South Sulawesi cannot be separated from pests such as *Spodoptera frugiperda*. J.E Smith. *S. frugiperda* is a new invasive pest in Indonesia and has been reported to spread throughout the provinces including South Sulawesi. However, information on *S. frugiperda* damage in South Sulawesi was still limited. This study aims to determine the damage caused by *S. frugiperda* to corn plants in the potential agricultural climate zones in South Sulawesi, namely the west, east and transitional sectors. Surveys from October to December 2022 were carried out in 3 regencies representing each climate zones in South Sulawesi. Field observations were carried out on 50 plant samples at each location, using the scouting method. Estimate the severity using a visual rating scale from 1 (no damage) to 5 (plant stunting and funnel damaged severely). The intensity of attack during the observation recorded the highest rate of attack in the transitional sector (Luwu Regency) of a total damage category and attack intensity of 48.7%. The highest larvae density was in the transitional sector (Luwu Regency) with an average range of 0.04-0.52 larvae/50 plants, while the lowest was in the west sector (Takalar Regency) with an average range of 0.04-0.06 larvae/50 plants). The infested corn plants in the all climate zone in South Sulawesi showed various typical damage caused by *S.frugiperda*

**Keywords**: attack intensity, corn, larvae population, *Spodoptera frugiperda*

1. **Introduction**

South Sulawesi is one of the contributors to corn production in Indonesia. The climate potential in South Sulawesi for agricultural development such as corn, is very supportive, and the development areas are grouped into three sections based on the relative similarity of the climatic zones, namely the West, East and Transitional Sectors. The western sector is influenced by westerly winds, and the eastern sector is influenced by easterly winds which are closely related to the rainy and dry seasons [1].

Corn as one of the main commodities in South Sulawesi cannot be separated from pests attack such as *Spodoptera frugiperda*. J.E Smith. *S.frugiperda* is a new invasive pest that comes from American [2], [3] and was detected in Indonesia in early 2019 in West Pasaman District, West Sumatra [4] and quickly spread to other provinces including South Sumatra [5], Lampung [6], West Java [7], Bengkulu [8], Bali [9], East Nusa Tenggara [10], and South Sulawesi [5].

* S.frugiperda* is polyphagous, primary hosts are food crops from the Graminae group such as corn, rice, wheat, sorghum, and sugarcane [11]. In addition *S.frugiperda* can migrate to other growing areas where primary hosts are available because imago is a long-range flier with a high cruising range[12]. *S.frugiperda* also caused damage to all stages of the corn plant starting from the vegetative phase to the generative phase. Mild larvae attacks can damage the surface of the leaf skin so that it appears transparent, whereas in heavy attacks there is frost around the corn [13].

The existence and development of the *S.frugiperda* population need to be watched out for because it can cause significant yield losses. Several studies have shown that *S.frugiperda* attacks in Indonesia are very high where the intensity of damage has reached 26.50% – to
70% in Lampung [14], 58.31% to 78.75% in East Java [15], 85% to 100% in East Nusa Tenggara [13], and 47.84% in Bali [9]. However, the information on \textit{S. frugiperda} damage in corn production centers in South Sulawesi was still limited. This study aims to determine the damage caused by \textit{S. frugiperda} to corn plants in the potential agricultural climate zones in South Sulawesi.

2. Material and Method

2.1 Study Area

This observation was carried out in three regencies which represents each climate zones in South Sulawesi and the selection of sub-districts in each regency is based on the location of corn production centers, namely Takalar (4°15'10.27"S 120° 0'47.10"E) from the west sector, Wajo (4°15'10.27"S 120° 0'47.10"E) from the east sector, and Luwu (3°16'10.21"S 120° 16'23.38"E) from the transitional sector, (Figure 1) started from October to December 2022.

![Figure 1: Map of the observation location](image)

2.2 Damage due to \textit{S.frugiperda}

Specifying plants are observed directly using the scouting method. This scouting method was used because the survey area is large and capable of covering all areas of land. The corn fields were scouted using a “W” pattern approach and the total sample observed was 50 plants (10 consecutive plants at five different spots along the “W” transect) [16]. The collected data was carried out every week for each observable location until the corn was six weeks.

The percentage of severity distinguished by the severity of pinholes, shot-holes, lesions, tattering and dead hearts was calculated using a rating scale for scoring damage severity on whorl-stage plants [14]. The percentage of attack intensity and the level of leaf damage were carried out by looking at the damage or attack symptoms caused by \textit{S. frugiperda} on the same corn plant sample which was scored based on the leaf damage scale according to [17] in Table 1.
Tabel 1. Visual rating scales for leaf damage assessment [17]

<table>
<thead>
<tr>
<th>Scale</th>
<th>Damage (%)</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>No damage</td>
</tr>
<tr>
<td>2</td>
<td>1-10</td>
<td>Little damage, &lt;5 mm diameter or only the leaf cuticle destruction</td>
</tr>
<tr>
<td>3</td>
<td>11-25</td>
<td>Medium damage, presence chewed areas &gt;5 mm, funnel leaves uninjured</td>
</tr>
<tr>
<td>4</td>
<td>26-50</td>
<td>Heavy damage, presence chewed areas &gt;1 cm, the funnel less severe</td>
</tr>
<tr>
<td>5</td>
<td>&gt;50</td>
<td>Total damage, plant stunting and funnel damaged severely</td>
</tr>
</tbody>
</table>

The scores and scales were calculated using the formula:

\[ K = \frac{\sum_{i=1}^{k} v_i \times n_i}{N \times Z} \times 100\% \]

Details: \( K \) = level of damage, \( v_i \) = pest attack scale, \( n_i \) = the number of sample plants, \( N \) = the total of sample plants, \( Z \) = the scale of highest pest attacked.

The total larval populations was counted directly by carefully observing the same sample of corn plants attack intensity. Observation of the larval populations was collected in the early morning starting from 06.00 to 09.00 a.m. because after 09.00 a.m. the larvae hid in the midrib of corn leaves.

2.3 Data Analysis

The average percentage of pest attacks was displayed in a graphical picture. Data on population density of larvae were also displayed in a graphical picture.

3. Result and Discussion

3.1 Population and damage caused by Spodoptera frugiperda in corn

Our observations show that the intensity of attacks during six weeks of observation at three different locations indicated moderate to severe attack symptom categories ranging from 20.8%-65.2% (Figure 2) damage level. The results of the analysis showed that the S. frugiperda attack on corn was started in the first week after planting (WAP) with a "medium" attack intensity (20.8%-23.2%)/plant. There were differences in the level of damage between the three observable locations, where the lowest level of damage occurred in Wajo and the highest level of damage occurred in Luwu. The highest attack of intensity in Takalar was found on corn plants at four weeks after planting (55.2%). While the highest intensity in Wajo was found in corn plants aged six weeks after planting (41.6%). In Luwu, the highest corn planting intensity was at five weeks after planting (65.2%). Those results indicate that S. frugiperda larvae have high destructive power and have the potential to reduce corn productivity in the field.
The intensity of the attack continued to increase with an attack rate of >50% on corn plants aged 4, 5, and 6 weeks after planting. This was under the [9] research that the severity of the larval attack reached its peak when corn was four weeks old, then attacks continued to decline at the age of eight weeks. The highest attack intensity at four weeks after planting is also suspected because the S. frugiperda pest has reached the 5th instar larval stage (adult larvae) where the caterpillars have started to have a slightly brown to light green color, so they need more food [18].

The three observation sites planted had different varieties of corn where in Takalar was BISI 18 varieties, Wajo was Pertiwi 5 varieties, and Luwu was ADV 777 varieties. Therefore, differences in varieties affect the level of attack of S. frugiperda. The data support the research of [19] that corn varieties have different levels of preference. ADV 777 Ruby (Luwu) is more susceptible to attack by S. frugiperda than corn varieties Bisi 18 in Takalar and Pertiwi 5 in Wajo. Based on varietal resistance research conducted by [20] on observing S. frugiperda attacks at plant ages around five weeks or the fast growth phase, it was found that Pertiwi 5 and Bisi 18 varieties had tolerance or resistance to S. frugiperda attacks compared to other varieties, namely P 36, NK Super, NK 7328, Exotic, and Local. Based on the attack criteria, the Pertiwi 5 and BISI 18 varieties were classified as varieties that were somewhat susceptible to a S. frugiperda attack.

Direct observations in the field showed that S. frugiperda larvae were very diverse, both in shape and size. Generally the larvae are found in leaf buds (Figure 3A), damaging the growing point of the plant and eating the inside of the plant by setting aside food scraps around the corn leaves where traces of frass similar to sawdust (Figure 3B). Larvae feed on the leaves causing the leaf surface of the corn plant to become transparent (Figure 3C) then affecting the growth of corn plants to be stunted because of the point grow infected. The same damage characteristics of S. frugiperda were also found by [8] and [21].
Population’s larvae of *S. frugiperda* were found at two weeks after planting in Luwu and three weeks after planting in the Takalar and Wajo which are described in Figure 4. The highest larvae density was in the transitional sector (Luwu) with an average range of 0.04-0.52 larvae/50 plants, with land observation being dry land formerly planted with cocoa. Corn planting is not carried out simultaneously, where there is around the observation area corn planting land that is 1 month older than the corn observation field. This causes the large number of larvae found compared to the other two observable locations. This is in line with [4] which stated that late crops were planted compared to surrounding plantations had a higher probability visited by female moths to lay their eggs.

The lowest larvae density was in the western sector (Takalar) with an average range of 0.04-0.06 larvae/50 plants. The observable area was a large dry land above the hills and the farmers in the area did not do simultaneous planting which caused the age of the corn plants different. According to farmers in this area, in recent seasons there has been a decrease in the
population of *S. frugiperda* larvae that attack corn plants. It is supported by data from the Center for Food Crops and Horticulture Protection of South Sulawesi displays data in the broad 2022 (January-October) time frame. The area of the corn affected by *S. frugiperda* in Takalar is 3.95 Ha. Control efforts have been successful so that there is a decrease in very significant between the area of the corn affected at the beginning of emergence this pest attack is an area of 170.55 ha (2019).

The difference in the amount of larvae found may be due to the number of larvae observed in each plant. The results showed that the number of larvae in the plantings was around 1-3 larvae, according to [19], the smaller the larval stage, the greater the number of larvae found in the plantations and conversely, the larger the larval stage, the smaller or tend to be solitary or in one plant. This condition is also supported by [18] which shows that the population of the corn pest *S. frugiperda* is dominated by one or two crop larvae because the larger larvae are cannibals. [22] stated that cannibalistic behavior occurs in the larval stage, where larger larvae eat smaller larvae.

Another factor that causes differences in attack intensity and the population is the climate which includes temperature, rainfall, and humidity. The study reported that the average temperature in Takalar was 29.41°C with 78.39% humidity, the average temperature in Wajo was 30.69°C with 82.46% humidity, and the average temperature in Luwu was 27.06°C with a humidity of 86.82%. The high larval population and attack intensity in Luwu are influenced by temperature, where the temperature at that location is the optimum temperature for the development of *Spodoptera frugiperda* larvae. This is support the research [18] that the optimum temperature for the development of *spodoptera frugiperda* larvae is 28°C (development can take place in a time range between 11°C and 30°C. [23] also added that optimum for the growth of *S. frugiperda* ranges from 24°C - 33°C with 60% to 90% humidity.

4. Conclusion

The infested corn plants in all climate zone in South Sulawesi showed various typical damage caused by *S. frugiperda*. The intensity of attacks during observations showed moderate to severe categories of attack symptoms ranging from 20.8% -65.2% with the highest attack intensity in the transitional sector (Luwu Regency) with total damage category and attack intensity of 48.7%. The highest larvae density was in the transitional sector (Luwu Regency) with an average range of 0.04-0.52 larvae/50 plants, while the lowest was in the west sector (Takalar Regency) with an average range of 0.04-0.06 larvae/ 50 plants).

5. Acknowledgment

The authors would like to thank the Indonesia Education Endowment Fund - LPDP for funding this research.

Reference


